CSIRO PUBLISHING
www.publish.csiro.au/journals/wr *Wildlife Research*, 2005, **32**, 63–65

Diving behaviour of two Ross seals off east Antarctica

Colin Southwell

Australian Antarctic Division, Department of the Environment and Heritage, Channel Highway, Kingston, Tas. 7050, Australia. Email: colin.southwell@aad.gov.au

Abstract. The Ross seal (*Ommatophoca rossii*) is the least frequently sighted and least known of the Antarctic pinnipeds. Current knowledge of foraging and diving behaviour is based on observations of a single seal over <2 days. The current study provides some additional data on the diving behaviour of two Ross seals off east Antarctica over periods of 31 and 12 days during December–January 1999–2000 using satellite-linked dive recorders. Both seals remained over the continental shelf for these times, the female remaining some distance from the coast and the male moving close to the coast approximately half-way through his transmission period. Most dives by the female reached depths >150 m (maximum depth 372 m) and the modal duration was 10–11 min. The male's dives were slightly shallower (most >100 m) and shorter (mode 6–7 min) when distant from the continental coast, and were truncated to a depth of 180 m when close to the coast, presumably by the sea floor. These dive patterns suggest that their prey species, thought to comprise mostly fish and squid, were relatively unavailable at depths <100 m.

Introduction

The Ross seal (*Ommatophoca rossii*) is the least frequently sighted and least known of the Antarctic pinnipeds. Most of the limited information on its biology and ecology comes from opportunistic observations from ships traversing the pack-ice (e.g. Thomas *et al*. 1980), sightings during aerial and shipboard surveys aimed at estimating distribution and abundance of Antarctic pinnipeds (e.g. Gilbert and Erickson 1977), or samples from captured or killed animals (e.g. Øritsland 1970; Skinner and Klages 1994). Knowledge of diving behaviour, which can give important insights into the role of this species in the Southern Ocean ecosystem, cannot be obtained using these methods of data collection and hence remains very poor.

The development of electronic dive recorders has revolutionised our ability to study pinniped behaviour. To date, advances in our knowledge of the behaviour of Antarctic pinnipeds using these instruments have focussed on the more abundant and accessible crabeater (*Lobodon carcinophagus*) and Weddell (*Leptonychotes weddelli*) seals (Bengtson and Stewart 1992; Testa 1994; Norday *et al*. 1995). Previous insight into the foraging behaviour of the Ross seal from electronic dive recorders is limited to a single study of one animal over <2 days (Bengtson and Stewart 1997). This paper aims to improve upon the very limited information on foraging behaviour of Ross seals by describing the diving patterns of two Ross seals over longer periods using electronic dive recorders.

Methods

ARGOS satellite-linked dive-recorders were deployed on two Ross seals (1 male on 11 December 1999; 1 female on 16 December 1999) in the Australian Antarctic Territory at locations <50 km north of the shelf break and >100 km from the Antarctic continent (male: 64°44′S, 131°08′E; female: 64°37′S, 110°35′E). The dive-recorders (Wildlife Computers, Redmond, WA, USA) were equipped with a 0–500-m pressure transducer that measured depth to a resolution of 2 m at 10-s intervals. The data were summarised for transmission to satellites as a histogram for each of three dive parameters – maximum dive depth (upper limits set as 10, 20, 30, 40, 50, 60, 80, 100, 150, 200, 250, >250 m), time-at-depth (upper limits: 10, 20, 30, 40, 50, 60, 80, 100, 150, >150 m) and dive duration (upper limits: 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, >13 min) – where 10 m was the minimum depth and 1 min the minimum time recorded as a dive. Histogram data were recorded and transmitted separately for 4 × 6-h periods of each day: 0300–0900, 0900–1500, 1500–2100 and 2100–0300 hours (local time). The absolute maximum depth reached each day was transmitted in addition to these histograms.

In addition to receiving the transmitted dive data, Service ARGOS can estimate location if >1 transmission is received by the satellite in a short period. The precision of these estimates is related to the number of transmissions and the time within which they are received. Service ARGOS defines 4 levels of precision (LC3: precision [as 1 s.d.] = 150 m; LC2: precision = 350 m; LC1: precision = 1000 m; LC0: precision not guaranteed, user determines quality).

Results and discussion

Dive data were received from the dates of capture to 10 January 2000 for the male (31 days after capture) and to 27 December 1999 for the female (12 days after capture). Although transmissions were received from both dive-recorders from the time of capture through to mid-March 2000 (male: 90 days; female: 97 days), data are presented only for the days prior to an apparent sudden and complete cessation of diving on the above dates, which I consider to have resulted from the dive-recorders being shed onto the ice as the seals moulted (Ross seals are thought to moult in January: Skinner and Klages 1994). Data from the first two days after capture were discarded from analysis to minimise

10.1071/WR03090 1035-3712/05/010063

any potential effect of capture on interpretation of diving behaviour.

Locations of quality LC1 or better were received on 7 of 10 days in the period 18–27 December for the female and 26 of 29 days in the period 13 December to 10 January for the male. Both seals moved southwards after release, crossing the shelf break within two days and remaining over the continental shelf (ocean depth <500 m) for the remainder of the time when dive data were received. As data from the initial two days after capture were discarded (see Methods), all dive data presented here are for locations over the continental shelf. While the female never moved closer than 70 km from the Antarctic coast, the male moved very close to the coast on 28 December and remained within 20 km of the coast until 10 January, when dive transmissions ceased. I pooled data across all 10 days in the period 18–27 December for the female, and split data for the male into two periods corresponding to localities distant from (>20 km, 13–27 December) and close to (<20 km, 28 December to 10 January) the coast.

There were no strong differences in diving behaviour between the four daily 6-h periods for either seal. Consequently, data presented here are pooled over these periods. Most dives (86%) by the female were to depths >150 m, with 63% of her time spent at these depths (Fig. 1). The maximum depth reached by this seal was 372 m on 22 December. Dive duration showed a bimodal distribution, with a primary modal duration of 10–11 min, and a minor secondary peak of short dives lasting 1–2 min (Fig. 1). Dives by the male were shorter and shallower. From 13–27 December, when the male spent most of his time distant from the coast, 50% of dives reached depths >150 m, 29% of time was spent at depths >150 m, and the modal duration of those dives was 6–7 min (Fig. 1). However, the maximum depth reached during this time, 388 m, was similar to that for the female. From 28 December to 10 January, when the male was close to the coast and likely to be in shallower water, dive histograms were further truncated, with only 13% of dives >150 m, 7% of time spent at depths

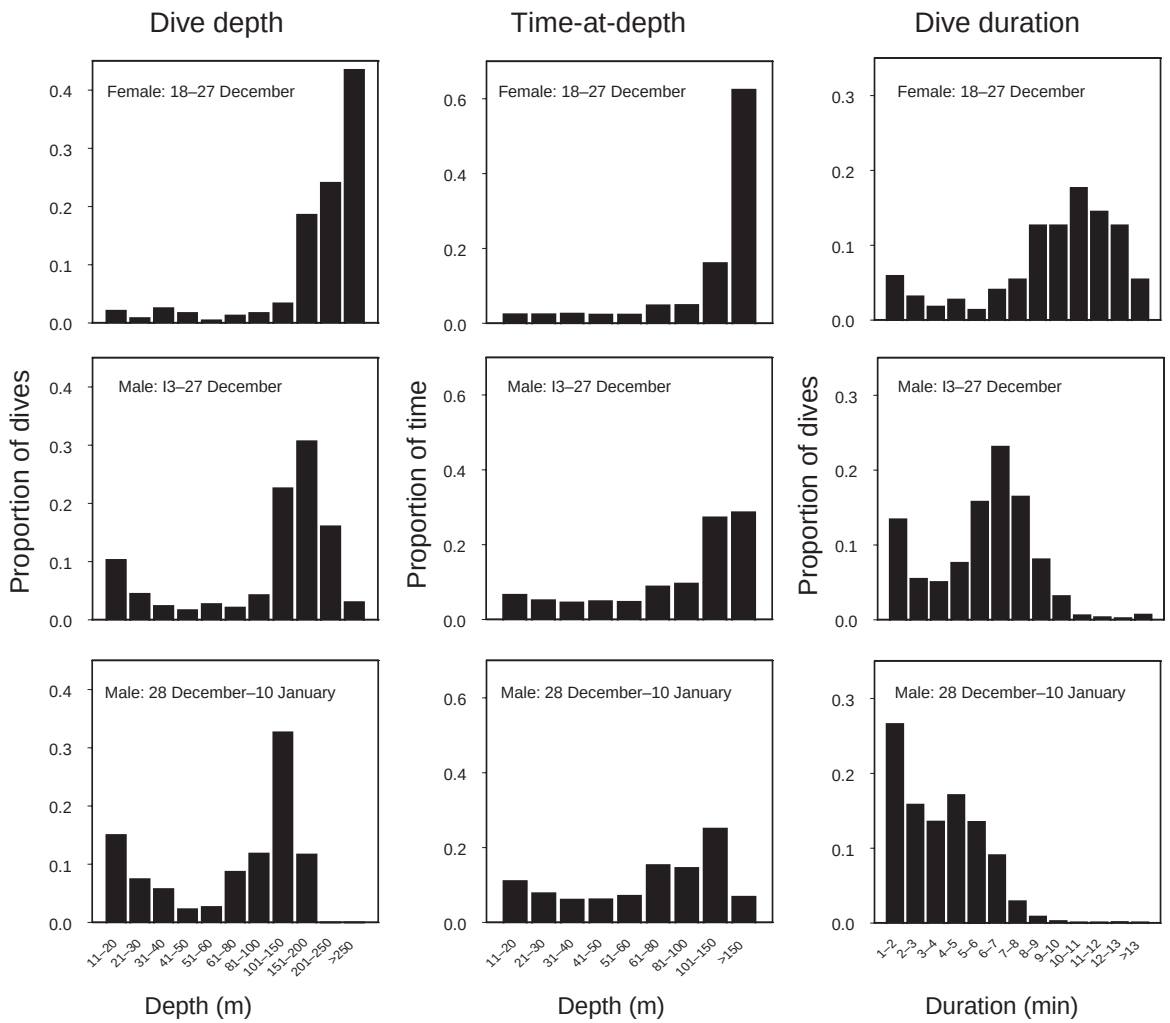

Fig. 1. Histograms of maximum dive depth, time-at-depth and dive duration for two Ross seals off east Antarctica.

>150 m, a modal dive duration of 1–2 min, and a maximum depth reached of only 180 m. This truncation of diving behaviour when close to the coast is likely a reflection of the seal diving to, or close to, the sea floor.

With dive data summarised as histograms it is not possible to describe individual dives or the fine detail of dives, as did Bengtson and Stewart (1997), who used a retrievable dive recorder. They found dives by a single seal to be characterised by a rapid descent to maximum depth (average 110 m, maximum 212 m), a sustained time at depth (average total dive duration 6.4 min, maximum 9.8 min) where the seal often made a series of short vertical excursions, which they referred to as prey-pursuit movements, then a rapid ascent to the surface.

Although sample sizes are still extremely small, this study confirms that the diving behaviour observed for a single seal over <2 days by Bengtson and Stewart (1997) is closely exhibited by other individuals and over longer time scales, and hence strengthens our confidence that these patterns may be more generally representative of the species. While both inter- and intra-individual variations were observed in this study, these differences are minor when contrasted with the diving behaviour of the crabeater seal, which is a specialist predator of Antarctic krill (*Euphausia superba*) and forages almost entirely in the top 30 m of the water column (Bengtson and Stewart 1992; Norday *et al*. 1995). The small amount of data available on the diet of the Ross seal suggests that it primarily eats fish and squid (Øritsland 1977; Skinner and Klages 1994), and the relatively deep dives by the Ross seal compared with the crabeater seal are likely to reflect differing availabilities at depth of their respective prey species. A change in the diel haulout pattern by the male (Southwell 2003) at the time when he was close to the coast and dives were truncated may be related to a change from pelagic to demersal prey and their associated activity or availability.

Acknowledgments

I thank Julie Barnes, Rick Van Veen, Brendan Hill, Garry Clothier, David Taylor and Mark Fletcher for their assistance in capturing seals, and the captain and crew of the MV *Aurora Australis*. This work was undertaken under permit 99/2 of the Commonwealth of Australia Antarctic Seals Conservation Regulations and was approved by the Antarctic Animal Ethics Committee. The manuscript was improved by comments from Judy Clarke and an anonymous referee.

References

Bengtson, J. L., and Stewart, B. S. (1992). Diving and haulout behavior of crabeater seals in the Weddell Sea, Antarctica, during March 1986. *Polar Biology* **12**, 635–644. doi:10.1007/BF00236986

Bengtson, J. L., and Stewart, B. S. (1997). Diving patterns of a Ross seal (*Omnatophoca rossii*) near the eastern coast of the Antarctic Peninsula. *Polar Biology* **18**, 214–218. doi:10.1007/S0030000 50178

Gilbert, J. R., and Erickson, A. W. (1977). Distribution and abundance of seals in the pack ice of the Pacific sector of the Southern Ocean. In 'Adaptations within Antarctic Ecosystems'. (Ed. L. Llano.) pp. 703–740. (Smithsonian Institute: Washington, DC.)

Norday, E. S., Folkow, L., and Blix, A. S. (1995). Distribution and diving behaviour of crabeater seals (*Lobodon carcinophagus*) off Queen Maud Land. *Polar Biology* **15**, 261–268.

Øritsland, T. (1970). Sealing and seal research in the south west Atlantic pack ice, Sept–Oct 1964. In 'Antarctic Ecology'. (Ed. M. W. Holdgate.) pp. 367–376. (Academic Press: London.)

Øritsland, T. (1977). Food consumption of seals in the Antarctic pack ice. In 'Adaptations Within Antarctic Ecosystems'. (Ed. G. A. Llano.) pp. 749–768. (Smithsonian Institute: Washington, DC.)

Skinner, J. D., and Klages, N. T. W. (1994). On some aspects of the biology of the Ross seal *Ommatophoca rossii* from King Haakon VII Sea, Antarctica. *Polar Biology* **14**, 467–472. doi:10.1007/ BF00239051

Southwell, C. (2003). Haul-out behaviour of two Ross seals off eastern Antarctica. *Antarctic Science* **15**, 257–258. doi:10.1017/S095410 2003001251

Testa, J. W. (1994). Over-winter movements and diving behaviour of female Weddell seals (*Leptonychotes weddelli*) in the southwestern Ross Sea, Antarctica. *Canadian Journal of Zoology* **72**, 1700–1710.

Thomas, J., DeMaster, D., Stone, S., and Andriashek, D. (1980). Observations of a newborn Ross seal pup (*Ommatophoca rossii*) near the Antarctic peninsula. *Canadian Journal of Zoology* **58**, 2156–2158.

Manuscript received 25 September 2003, accepted 20 September 2004